REMARKS

This application has been carefully reviewed in light of the Office Action mailed on February 27, 2003. Claim 1 has been amended. A marked-up version of this claim, showing changes made, is attached hereto as Appendix A. Reconsideration of the above-referenced application in light of the amendments and following remarks is requested.

Claims 1-4, 6-8, and 10-17 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over McInerney in view of Fong. Reconsideration is respectfully requested.

McInerney in view of Fong does not teach or suggest the subject matter of claim 1. The Office Action asserts that McInerney teaches "a first region (112 or 116) [which] is capable of applying a first gas species and a second region (114 or 118) [which] is capable of a second processing step." (Page 2). As support, the Office Action cites Col. 5, row 14. However, Col. 5, row 14 merely recites showerheads 136 and 138 and not a first and second region.

The Office Action further asserts that McInerney teaches that "all regions are adjacent and chemically isolated form [sic] one another by an inert gas curtain of argon." (Page 2). As support, the Office Action cites Col. 8, row 37. Again however, Col. 8, row 37 merely recites that Fig. 10 is an exploded perspective view of chamber 200. It does not depict "first and second doping regions being chemically isolated from one another by an inert gas curtain," as recited in claim 1. McInerney does not teach these items as the Office Action claims.

McInerney teaches a multi-station processing chamber useful for incompatible processes, such as when "incompatible reactive gases . . . are used." (Col. 1, lines 27-33). This is an important feature of McInerney. One skilled in the art would understand that McInerney teaches a first region 112 for depositing a first gas species and a second region 114 for depositing a second gas species. Since McInerney teaches that incompatible processes can be employed in separate chambers, one skilled in the art would employ a

second gas species, incompatible with the first gas species of the first chamber 112, to be deposited in the second chamber 114. Such a person would not use McInerney's second chamber for diffusing first dopant species since this process is not an incompatible process and can be carried out in the first chamber 112.

To increase the throughput of multi-station processing chambers, which McInerney is directed to, one skilled in the art would not use McInerney's second chamber 114 for diffusion since this would decrease throughput. Such a person would diffuse the first gas species in the first chamber 112 and then move the substrate into the second chamber 114. In this manner, throughput would increase.

Moreover, McInerney does not teach an inert gas curtain. McInerney teaches that "gas flows from highest pressure to lowest pressure . . .[and] are drawn down into respective wells 126 and 128 via annular gaps 126a and 128a." (Col. 5, lines 31-42). "The reactive gases and the inert gas, are drawn into wells 126 and 128 through respective annular gaps 126a and 128." (Fig. 11 and Col. 8, lines 59-66). The use of an inert gas in McInerney merely "assists in directing the flow of the reactive gases down into the wells where the reactive gases are drained out." (Col. 11, lines 57-62) (emphasis added).

The present invention, however, provides that "the pressure of the inert gas 360 must be higher than that of the first dopant gas Ax and that of the non-reactive gas By, so that the two doping gases Ax, By are constrained by the gas curtain 300 to remain within their respective reaction chambers." (Applicants' specification, pg. 18, lines 19-21 through pg. 19, lines 1-2) (emphasis added). Accordingly, "gas curtain 300 provides chemical isolation to all adjacent deposition regions." (Applicants' specification, pg. 18, lines 11-12) (emphasis added). Applicants' inert gas curtain maintains physical separation of the adjacent reaction chambers.

The Office Action relies upon Fong for teaching a second processing region to drive in dopants. However, Fong does not teach "deposition of a dopant species in a first processing region and transfer to a second processing region" as the Office Action asserts

(Page 2). In fact, Fong teaches away from using two separate processing regions. Fong is directed to providing an apparatus which "enables multiple process steps to be performed in situ in the same chamber to reduce total processing time and to ensure high quality processing." (Col. 7, lines 24-26) (emphasis added).

In support, the Office Action cites Col. 41, row 61 through Col. 42, row 12 for teaching a second processing region. However, Fong specifically teaches that "[a]fter the deposition of doped dielectric layer 1008, the wafer remains in chamber 15." (Col.41, lines 61-62) (emphasis added). Fong is entirely directed to allowing "multiple process steps to be performed in situ in the same chamber to reduce total processing time . . . [and] also increases the control of the process parameters and reduces device damage," (Abstract). Even assuming arguendo, that Fong teaches or suggests a second processing region, Fong is not properly combinable with McInerney.

Fong teaches multiple processes in the same reaction chamber whereas McInerney is directed to incompatible processes in separate reaction chambers. Still further, using McInerney's second chamber 114 for diffusion would decrease throughput. The addition of a process in a separate chamber would increase the length of time necessary to process the substrate, which is directly against the primary goal of McInerney, increasing throughput. Moreover, McInerney does not teach an inert gas curtain. Fong does not rectify this deficiency associated with McInerney.

Accordingly, the cited references do not teach or suggest an atomic layer doping apparatus comprising "a first atomic layer doping region for depositing a first dopant species . . . a second atomic layer doping region for diffusing said first dopant species . . . said first and second doping regions being chemically isolated from one another by an inert gas curtain," as recited by claim 1 (emphasis added).

Claims 2-4, 6-8, 10-17 depend from and incorporate all of the limitations found in independent claim 1, and are similarly allowable along with claim 1 for at least the same reasons provided above with regard to claim 1.

Claim 5 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over McInerney and Fong and further in view of Straemke. Reconsideration is respectfully requested.

Dependent claim 5, which includes all limitations of independent claim 1, is allowable for at least the reasons provided above with regard to claim 1. In particular, McInerney and Fong are not properly combinable references since Fong teaches multiple processes in the same chamber and McInerney teaches multiple processes in separate chambers. Further, the combination of Fong and McInerney would decrease the throughput of McInerney's apparatus. Straemke is relied upon for teaching a physical barrier between adjacent deposition regions and adds nothing to rectify the deficiencies associated with McInerney and Fong.

Claim 9 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over McInerney and Fong and further in view of Henley. Reconsideration is respectfully requested.

Dependent claim 9, which includes all limitations of independent claim 1, is allowable for at least the reasons provided above with regard to claim 1. In particular, McInerney and Fong are not properly combinable. Henley is relied upon for teaching a third deposition region and adds nothing to correct the deficiencies associated with McInerney and Fong.

Claim 46 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over McInerney and Fong and further in view of Gattuso. Reconsideration is respectfully requested.

For similar reasons provided above with regard to claim 1, there is no motivation to combine McInerney and Fong. Fong teaches multiple processes in the same chamber and McInerney teaches multiple processes in separate chambers. Further, the combination of Fong and McInerney would decrease the throughput of McInerney's apparatus.

Gattuso is relied upon for teaching "an inert gas curtain provided at a pressure somewhat higher than that of the reaction gases within the chamber to create an effective, non-reactive gas curtain." (Office Action, pg. 5).

Gattuso teaches that "a significant amount of inert gas within the chamber can interfere with the deposition process." (Page 10, lines 28-30). As a result, there is no motivation to substitute McInerney's argon gas flow with Gattuso's inert gas curtain. The presence of Gattuso's inert gas curtain would decrease throughput rather than increase throughput.

Stated in another way, Gattuso teaches away from having an inert gas curtain that can interact or co-exist within a reactive chamber. McInerney's argon gas flow, directly interacts and co-exists with reaction chamber 116 and 118's gas species (Figure 3). Thus, one skilled in the art would not be motivated to substitute McInerney's inert argon gas flow with Gattuso's inert gas curtain since Gattuso teaches that it is undesirable for the inert gas to enter the reaction chamber.

Moreover, McInerney's apparatus teaches a pressure gradient which serves to remove reactive gases out of chambers 116 and 118. Combining McInerney and Gattuso would produce a system in which an inert gas curtain is provided at a higher pressure than the reactive gases in McInerney's chambers 116 and 118. This would nullify the pressure gradient taught in McInerney and defeat the very purpose of McInerney. The reactive gases would no longer be exhausted through McInerney's exhaust port 140 since the pressure gradient would no longer exist if a higher pressure inert gas curtain is introduced separating McInerney's chambers 116 and 118.

Accordingly, the cited references do not teach or suggest an atomic layer doping apparatus comprising "a first atomic layer doping region for depositing a first dopant species . . . a second atomic layer doping region for diffusing said first dopant species . . . said first and second doping regions being chemically isolated from one another, wherein said inert gas curtain is provided at a higher pressure than said first dopant species," as

recited by claim 46 (emphasis added).

Claim 47 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over McInerney and Fong and further in view of Hartig. Reconsideration is respectfully requested.

For similar reasons provided above with regard to claim 1, McInerney and Fong do not teach or suggest claim 47 since there is no motivation to combine the references. Fong teaches multiple processes in the same chamber and McInerney teaches multiple processes in separate chambers. The combination of Fong and McInerney would decrease the throughput of McInerney's apparatus. Hartig is relied upon for teaching the use of a separate gas exhaust for each region in a multi-chamber apparatus.

The Office Action asserts that since McInerney teaches different showerheads 136 and 138, each of the showerheads can be connected to a non-reactive gas supply source. However, the fact that McInerney's showerheads can be utilized in such a manner does not mean that they can actually be used in that manner. McInerney does not teach or suggest connecting a non-reactive gas supply source to either showerheads 136 and 138. This is a fact acknowledged in the Office Action. The Office Action states, "[e]xaminer realizes that the prior art fails to explicitly teach the use of a non-reactive gas in a second region." (Page 6). In fact, McInerney actually teaches the opposite. McInerney teaches connecting two reactive gases to each respective showerhead 136 and 138.

The Office Action then concludes that the combination of McInerney and Fong teach "first and second doping regions capable of depositing a doping species in a first region and allowing that species to diffuse with the assistance of a non-reactive gas in a second region." (Page 6). However, McInerney is directed to incompatible gas processes. The function of the first showerhead 136 is to provide a first reactive gas species in a first gas chamber 116, and the second showerhead 138 is to provide a second reactive gas species in a second gas chamber 118. McInerney's primary goal is to provide a multi-chamber apparatus in which two reactive gas species can be directed to a substrate in two

separate chambers. This increases throughput. As a result, there is no motivation to connect showerheads 136 or 138 with a non-reactive gas species as the Office Action asserts.

Moreover, McInerney and Fong do not teach or suggest using a non-reactive gas in a second region. McInerney teaches employing a reactive gas in the second reaction chamber 118. Fong teaches diffusing the dopant species in the same reaction chamber that deposited the dopant species. As a result, the prior art fails to teach or even suggest a second region that employs a non-reactive gas that assists in diffusing the first dopant species from the first region. In fact, it is impossible to do so with the cited prior art.

The Office Action further argues that Hartig teaches the use of individual gas exhaust ports for each reactive chamber. Yet, there is no motivation to combine Hartig and McInerney, and once again, the references are not properly combinable and any motivation for the proposed combination is missing. Hartig is directed to providing a multi-chamber coating apparatus for transporting glass slabs. In this manner, "very bulky, especially curved, sheet glass can easily be coated into an adjacent coating chamber without the occurrence of significant gas transfer between the individual chambers." (Col. 1, lines 33-38).

Hartig's apparatus and McInerney's apparatus are materially different from each other. Hartig's apparatus processes large slabs of glass. In contrast, McInerney's apparatus processes semiconductor wafers. Thus, these are two completely different materials requiring different processing sequences and apparatuses. Clearly, this is non-analogous to the wafer processing described in the McInerney and Fong references and is inherently not combinable with references dealing with glass processes. One skilled in the art would not be motivated to combine the teachings of these references.

Moreover, McInerney teaches away from an apparatus with an exhaust port for each reactive chamber. McInerney teaches that the "exhaust port 140 [is] located at the bottom of and is fluidically coupled to well 126 and well 128." (Col. 4, lines 59-60)

(emphasis added). McInerney's single exhaust port 140 is connected to both reactive chambers 116 and 118, and thus, negates any motivation to provide separate exhaust ports for each reactive chamber. McInerney's argon gas flow directs the first reactive gas species from chamber 118 and the second reactive gas species from chamber 118 into the single exhaust port. There is no motivation to aspirate each chamber as the Office Action asserts.

Accordingly, the cited references do not teach or suggest an atomic layer doping apparatus comprising "a first atomic layer doping region for depositing a first dopant gas species . . . said first dopant gas species exhausted through a first gas port, a second atomic layer doping region for diffusing said first dopant gas species with a non-reactive gas species, said first and second doping regions being chemically isolated from one another, wherein said non-reactive gas species is exhausted through a second gas port," as recited by claim 47.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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Respectfully submitted,

By _____
Thomas J. D'Amico
Registration No.: 28,371
DICKSTEIN SHAPIRO MORIN &
OSHINSKY LLP
2101 L Street NW
Washington, DC 20037-1526
(202) 785-9700
Attorney for Applicants

James Deery

APPENDIX A

1. (amended) An atomic layer doping apparatus comprising:

a first atomic layer doping region for depositing a first dopant species on a first substrate as a monolayer;

a second atomic layer doping region for diffusing said first dopant species in said first substrate, said first and second doping regions being chemically isolated from one another by an inert gas curtain; and

a loading assembly for moving said first substrate from said first doping region to said second doping region, thereby enabling deposition of a first atomic monolayer in said first doping region, followed by diffusion of said first atomic monolayer in said second doping region.